

WHAT IS CLAIMED IS:

1. A reaction control system for controlling motion of a spacecraft or other vehicle, the reaction control system comprising:

at least one pulsed detonation engine comprising one or more propellant valves, an igniter, a detonation chamber, and a nozzle;

wherein the at least one pulsed detonation engine is adapted to controllably ignite detonation of a propellant to generate thrust in a predetermined vector for controlling motion of said spacecraft or other vehicle.

2. The reaction control system of claim 1 which comprises a plurality of pulsed detonation engines capable of generating thrust in a plurality of vectors.

3. The reaction control system of claim 2 further comprising a controller for controlling operation of said plurality of pulsed detonation engines, wherein the controller is selected from the group consisting of a piezoelectric device, a thermo-fluidic device, a microelectronic mechanical system, an electromagnetic system, and combinations thereof.

4. The reaction control system of claim 3 wherein said plurality of pulsed detonation engines comprises a plurality of channels in a solid body.

5. The reaction control system of claim 4 further comprising a common valve for controllably injecting propellant into said plurality of channels.

o 6. The reaction control system of claim 1 wherein said at least one pulsed detonation engine comprises a detonation chamber having a groove which contains or partially contains a propellant prior to detonation.

7. The reaction control system of claim 1 wherein said at least one pulsed detonation engine comprises a detonation chamber having an igniter positioned downstream of a point at which propellant is injected.

8. The reaction control system of claim 1 wherein said at least one pulsed detonation engine comprises an igniter selected from the group consisting of a spark plug, a pyrotechnic device, and a laser.

9. The reaction control system of claim 1 further comprising an electrical energy regeneration and storage device capable of permitting remote operation of said at least one pulsed detonation engine for extended periods of time.

10. A spacecraft comprising the reaction control system of claim 1.

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11. A missile intercept vehicle comprising the reaction control system of claim 1.

12. A reaction control system for controlling the motion of a spacecraft, missile or other vehicle, the reaction control system comprising:

at least four pulsed detonation engines arranged in a cruciform for selectively generating thrust in at least four vectors, wherein each of said pulsed detonation engines comprises electronically controlled propellant valves, an igniter, a detonation chamber, and a nozzle;

a controller for selectively actuating said at least four pulsed detonation engines, the controller comprising at least one of a piezoelectric device, a thermo-fluidic device, an electromagnetic device, and a microelectronic mechanical system.

13. A spacecraft or missile comprising the reaction control system of claim 12.
14. A method of controlling motion of a spacecraft or other vehicle with a reaction control system, the method comprising generating thrust in a predetermined vector by controllably igniting detonation of a propellant in at least one pulsed detonation engine in said reaction control system.
15. The method of claim 14 which comprises controllably generating thrust in a plurality of vectors by controllably actuating a plurality of pulsed detonation engines in said reaction control system.
16. The method of claim 14 wherein said propellant is injected into a detonation chamber of the pulsed detonation engine during a controlled injection time of from about 0.01 to 1,000 msec.
17. The method of claim 16 wherein the controlled injection time is from about 0.1 to about 10 msec.

18. The method of claim 14 wherein said igniting detonation is delayed from about 0.1 to about 100 msec following injection of said propellant into a detonation chamber of said pulsed detonation engine.

19. The method of claim 18 wherein said igniting detonation is delayed from about 0.1 to about 10 msec following injection.

20. The method of claim 14 wherein detonation velocity in said at least one pulsed detonation engine is limited to about 1 to about 5 km/s.

21. The method of claim 20 wherein the detonation velocity is limited by adding material to the propellant to reduce propellant density.

22. The method of claim 14 wherein said propellant comprises a liquid propellant having a density of from about 0.001 to about 0.5 g/cc.

23. The method of claim 14 wherein said propellant comprises a gas containing particles having an average particle size of about 10 μm or less and a liquid or gaseous oxidizer.

24. The method of claim 23 wherein said propellant comprises aluminum particles.

25. The method of claim 23 wherein said propellant comprises a suspension of magnesium particles.

26. The method of claim 14 wherein said propellant comprises gaseous aluminum and a liquid or gaseous oxidizer.

27. The method of claim 14 wherein propellant comprises a suspension of gaseous magnesium.

28. The method of claim 14 wherein said propellant comprises nanoscale particles.

29. The method of claim 28 wherein said propellant comprises a liquid propellant and wherein said nanoscale particles are present in a concentration of from about 0.1 to about 1 wt% effective to activate the propellant.

30. The method of claim 28 wherein the nanoscale particles are present in the propellant in a concentration of from about 1 to 15 wt% effective to reduce detonation velocity and pressure.

31. The method of claim 28 wherein the nanoscale particles increase or decrease the dielectric properties of the propellant.

32. The method of claim 28 wherein the nanoscale particles absorb fuel on their surfaces, thereby rendering the nanoscale particles detonable.

33. The method of claim 14 wherein said propellant comprises one or more carbon structures selected from the group consisting of fullerenes, nanotubes, and nanoscale diamond.

34. The method of claim 14 wherein fuel and oxidizer are macroscopically mixed by impingement of fuel and oxidizer streams.

35. The method of claim 34 further comprising microscopically mixing said fuel and oxidizer.

36. The method of claim 14 wherein said propellant is injected into and dispersed within a detonation chamber and ignited while in the dispersed phase.

37. The method of claim 14 wherein said propellant is contained or partially contained in a groove in a detonation chamber prior to detonation.

38. The method of claim 14 wherein said propellant is injected into a detonation chamber by forming a thin layer of propellant along inner surfaces of the detonation chamber.

39. The reaction control system of claim 1 wherein the length of the at least one pulsed detonation engine is from about 5 to about 100 mm.

40. The reaction control system of claim 39 wherein the length is from about 5 to about 55 mm.

41. The reaction control system of claim 1 wherein the at least one pulsed detonation engine comprises a detonation chamber having a diameter of from about 0.01 mm to 10 mm.